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USSR Report

LIFE SCIENCES

EFFECTS OF NONIONIZING ELECTROMAGNETIC RADIATION

No. 7

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HYGIENIC EVALUATION OF BIOLOGICAL EFFECTS OF NONIONIZING MICROWAVES

Moscow GIGIYENA I SANITARIYA in Russian No 6, Jun 82 (manuscript received 11 Nov 81) pp 32-34

[Article by V. S. Belokrinitskiy, Kiev Scientific Research Institute of General and Communal Hygiene imeni A. N. Marzeyev]

[Text] Development of technological progress has caused appearance of microwave generators, which man is using more and more in various areas of his endeavors. As a result of the use of such generators in the national economy and everyday life, there is constant increase in number of people who come in contact with nonionizing microwave radiation (NMR), which is why it is necessary to determine the nature of biological effects of microwaves, degree of their harmfulness, set maximum permissible levels, develop preventive and protective measures.

In preparing hygienic regulations for any environmental factor, it is important to investigate processes that occur in the body under its influence and assess them from the standpoint of the concepts of "normal," "pathology" and "prepathology," which have long since drawn the attention of prominent Soviet pathologists (A. I. Strukov et al.). Prepathology is of the greatest importance to a preventive medical discipline, such as hygiene. As indicated by G. I. Sidorenko and Yu. I. Prokopenko, the only way to prevent any consequences from environmental pollution is to detect prepathology. However, even now, there is no unified conception of the ranges of what is normal and prepathology. These conceptions are discussed in the modern literature with reference to a wide range of changes in physical condition (Varma; G. I. Tsaregorodtsev and V. P. Alferov; Yu. I. Prokopenko, and others).

Moreover, the categories adopted to assess such states are debatable. The question of the place and physiological significance of adaptation in the healthy and sick has not been answered; there must be continued work on the question of degree of compensation as an indicator of deleterious effects of environmental factors, etc.

In addition, in the vast majority of cases, all of these phenomena are evaluated only on the basis of functional changes demonstrable by physiological methods, without consideration of data on the condition of structure.

At the Kiev Scientific Research Institute of General and Communal Hygiene imeni A. N. Marzeyev, studies of biological effects of NMR are based on the principle of unity of structure and function. For this reason, a set of various physiological, biochemical, immunological and histochemical methods is used, which permits demonstration of the distinctive features of reactions on different levels of organization and regulation. In many years of work, we have obtained extensive experimental material, which enables us to assess processes attributable to change in structure and function of tissues, cells and individual organoids of different elements of the brain and spinal cord, nerve trunks, liver, heart and kidneys due to exposure to SHF electromagnetic waves in the centimeter range. In different experiments, animals were exposed to microwaves of different intensity: 1-5, 10-15, 25-30, 50, 500, 1000 $\mu W/cm^2$, as well as 5-10 and 400-500 mlW/cm^2 [mlW--probably typo for mW].

The animals were exposed to microwaves in an anechoic shielded chamber, where they were put in special cages situated in the zone of formation of the electromagnetic field. We used a LUCh-58 unit as a generator (wavelength 12.6 cm). An engineer measured the energy flux density (EFD) by means of special type PZ-9 instruments.

We used both ordinary morphological methods and histochemistry, as well as electron microscopy in our study. We determined the following parameters: general condition of tissue structure, levels in cells of glycogen, neutral lipids and nucleic acids (RNA, DNA); activity of enzymes (succinate dehydrogenase--SDH, malate dehydrogenase--MDH, lactate dehydrogenase--LDH, glucose-6-phosphate dehydrogenase--G-6-PDH), which are key elements in redox and energy metabolism processes, as well as state of cellular ultrastructure, paying special attention to the structure of mitochondria and other organelles, on whose membranes the tested enzymes are concentrated and nucleic acid synthesis takes place.

We ran enzymatic reactions by the methods described in the book by A. Pearse. The reactions were assessed according to nature and topographic arrangement of diformasan granules in cells (I. D. Shperling and I. F. Gusakova) and scored on a 5-point scale. Electron microscopy was conducted by the method adopted in the laboratory of N. N. Bogolepov at the Brain Institute, USSR Academy of Medical Sciences.

It was determined that the earliest changes in the rat organs examined, with exposure to low levels of NMR (1-50 $\mu W/cm^2$), are a significant increase in SDH and G-6-PDH activity, insignificant increase in MDH and LDH activity, with marked utilization of glycogen and partial decrease in RNA content of cell cytoplasm. These biological effects were demonstrable immediately and on the first days after single exposure of animals to an SHF field with intensity of 50 $\mu W/cm^2$ for 3-7 h, as well as repeated exposure (up to 1 month, 7 or 3 h/day) to SHF with intensity of 5, 10 and 25 $\mu W/cm^2$.

With use of 10 and 25 $\mu W/cm^2$ SHF fields for 2 months, we observed changes in ultrastructure of brain cells, which were manifested by swelling of mitochondria, impaired integrity of their cristae, septa and membranes. The changes progressed when the animals were exposed to 50 $\mu W/cm^2$ SHF fields for 2 months at the rate of 40 min, 3 times a day, at 3-4-h intervals. We interpret the demonstrated changes in cellular oxidative process as a response aimed at producing additional energy and compensating cell functions, as also indicated by mitochondrial hyperplasia and hypertrophy.

Exposure of animals (rats) to SHF fields with intensity of 500 μW/cm^2 (once for 3 or 7 h) elicited more marked histochemical and structural changes in the cells. This dosage has a damaging effect not only on mitochondria, but other organoids, in particular, the endoplasmic reticulum, fine structures of the nucleus and nucleolus, which is associated with an increase in activity of the tested enzymes, changes in amount of glycogen and nucleic acids (RNA, DNA) in cells, indicative of impaired utilization and synthesis thereof. The changes did not revert to normal within 1 month after discontinuing exposure. However, a significant part of the indicators was restored within 2 months.

Multiple (at equal intervals) exposure to an SHF field of the same intensity (15 and 30 μW/cm^2) or repeated exposure to higher intensities (15 + 30 μW/cm^2 and, to a lesser extent, 15 + 30 + 50 μW/cm^2, for 3 h/day, 10 days each) caused enzyme activity to hold at an elevated level, as well as persistence of altered histochemical and structural parameters of cells and tissues of examined organs. Exposure of animals to an SHF field with intensity of 500 μW/cm^2 for 3 or 7 h, following prior irradiation, elicited less marked changes in tissues than delivery of the same doses to intact animals. The changes in histochemical and structural parameters of animals in this series of experiments are believed to be compensatory and adaptive, providing for some stability of metabolic processes and preservation of structures at a certain level. They are aimed against the deleterious effects of higher intensity SHF fields on functions.

When rats were exposed many times to SHF with intensity of 1000 μW/cm^2 (for 2 months, 3 times a day, 40 min at a time, at 3-4 h intervals, daily), there was significant decrease in cellular levels of glycogen and nucleic acids, increase in neutral lipid content, vacuolization of some parts of the cytoplasm, with significant change in shape and electron density of mitochondria, not only in cells but nerve fibers, increase in their quantity and dimensions, thinning and fragmentation of neurofibrils, impairment of integrity of membranes of the endoplasmic reticulum, change in electron density and density of arrangement of chromatin granules in the nucleus and nucleolus. This was associated with increase in activity of glial elements and cells of the reticuloendothelial system. We interpret these phenomena as dystrophic (reversible) processes. However, many of the tested parameters did not recover within 2 months after discontinuing exposure.

Single exposure to an electromagnetic SHF field of higher intensity (10 mW/cm^2 and particularly 400-500 mW/cm^2) of animals for 1 h (cats) and 4 h (dogs) elicited identical changes in tissues and cells of organs examined. They consisted of drastic dilatation of blood vessels (particularly arterioles and capillaries), friability of their walls, enlargement of intercellular and tissular spaces, vacuolization of nerve and parenchymatous cells, considerable decrease in their glycogen and nucleic acid content, to the extent of disappearance, drastic swelling and accentuation of elective properties of many cells, changes in their shape and dimensions, demyelinization and vacuolization of nerve fibers, etc. All these changes are well-marked when histological preparations are examined under an ordinary light microscope immediately or on the 1st day after discontinuing exposure. The changes in cells progress on the 10th, 20th and 30th days of the recovery period. They are more marked and seen more often in animals exposed to SHF fields with intenstiy of 400-500 mW/cm^2. We consider these processes irreversible. Animals develop a disease with clearcut clinical manifestations, which progress.

Analysis of the above experimental data revealed that the nature and severity of changes observed in the exposed organism depend on experimental conditions, in particular, dosage (intensity, duration and mode of exposure), time from start and after end of exposure at which tissues are examined, specific function of cells, their elements and organ as a whole, as well as initial condition of the organism.

In making a hygienic assessment of the demonstrated changes, which developed in an organism exposed to an SHF field, the question of general and special significance is important, not only to hygienic science, but pathology as a whole.

In the opinion of a number of scientists, there is poor development of problems related to systemic regulation, as well as those pertaining to the role of the nervous system in pathology, nervous trophics and nervism in general. In the opinion of D. S. Sarkisov, a false impression has currently appeared about the autonomy of intracellular processes, about the fact that they can proceed without involvement of the nervous system, and that the main problems of medicine can be solved without investigating these questions.

The advances of modern biology in the area of histochemistry and electron microscopy have expanded considerably our conceptions of pathology. Wide interest has appeared in pathological processes in the cell; a new branch of science has started to form--cellular pathology, or pathocytology, whose advances are finding increasingly wide application in various branches of biology and medicine. This direction of research has very broad prospects, and their applied nature renders them particularly important. This also applies to preventive medicine, such as hygiene.

Analysis of our investigations indicates that the parameters recorded by means of histochemical methods and electron microscopy are highly sensitive to SHF fields. Changes in these parameters make it possible to determine the possibility and range of structural changes in the cell, tissues, organs that are a morphological expression of the adaptation process. They also permit detection of early manifestations of disease, the gradual [step by step] nature of the adaptation process, deleterious effects of the factor, as well as compensatory capacities of the morphological substrate as related to frequency and force of the stimulus. Detection and extensive investigation of contradictory elements--damage and compensation--as well as intensity of two other opposite processes--lability of rhythm of physiological regulation of ultrastructure, frequency and force of the stimulus, could constitute the object of morphofunctional definition of prepathology, which is so important in hygienic regulation of SHF fields, with due consideration of age, concomitant diseases and duration of contact with this environmental factor, as well as in developing preventive and protective measures. All this is extremely promising and conforms entirely to development of modern science.

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HYGIENIC EVALUATION OF 8-MM WAVE ELECTROMAGNETIC FIELDS

Moscow GIGIYENA I SANITARIYA in Russian No 6, Jun 82 (manuscript received 12 May 81) pp 18-20

[Article by Yu. D. Dumanskiy and L. A. Tomashevskaya, Kiev Scientific Research Institute of General and Communal Hygiene imeni A. N. Marzeyev]

[Text] Our objective here was to determine the correlation between changes in some metabolic processes and intensity of electromagnetic fields (EMF) in the 8-mm wave range, generated by meteorological radar stations, in order to provide further scientific validation of the hygienic standard for this factor in residential areas.

We created a model of exposure in animal experiments, which is adequate for the actual mode of EMF with time characteristics of intermittence and levels of energy flux density (EFD).

Experiments were performed on 160 albino rats divided into groups corresponding to EFD of 140, 100 and 60 $\mu W/cm^2$. A group of intact animals kept under identical conditions with regard to temperature, humidity and diet served as a control. The animals were exposed to EMF for 12 h/day over a period of 4 months. This exposure corresponds to actual conditions when radar equipment used in the national economy is operated.

We assessed the dynamics of some biochemical processes in experimental animals on the basis of levels of blood serum urea and residual nitrogen, liver glycogen, blood cholinesterase activity, blood serum metalloenzymes--ceruloplasmin and transferrin, succinate dehydrogenase and cytochromoxidase in mitochondria of the liver and brain. The analyses were made on the 30th, 60th, 90th and 120th days of exposure to EMF, i.e., once a month.

The obtained results (Figure 1) revealed that, under the influence of 8-mm wave EMF with EFD of 140 $\mu W/cm^2$, there was an increase in blood serum urea content, which reached statistically significant values ($p<0.05$) in the 3d and 4th months of exposure. At the same times, there was a tendency toward elevation of urea level with exposure to EFD of 100 $\mu W/cm^2$. With 60 $\mu W/cm^2$ EFD, blood serum urea content did not differ from the control. Residual nitrogen level also rose toward the end of the exposure period with use of EMF with 140 $\mu W/cm^2$ EFD. With 100 and 60 $\mu W/cm^2$ EFD we failed to observe an appreciable difference from the control.

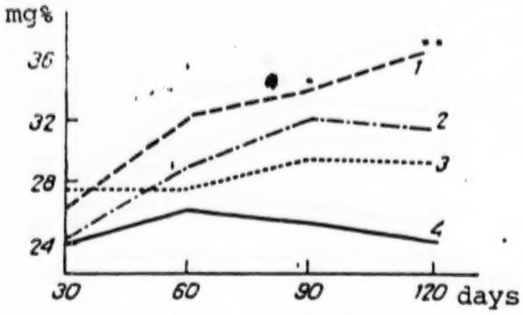

Figure 1.
Rat blood serum urea content with exposure to different levels of 8-mm wave EMF
1) 140 μW/cm^2 3) 60 μW/cm^2
2) 100 μW/cm^2 4) control
*$P<0.05$; **$P<0.01$

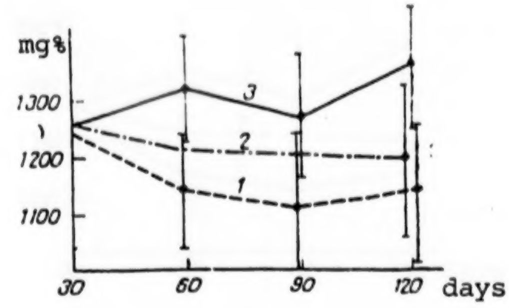

Figure 2.
Rat liver glycogen levels with long-term exposure to different levels of 8-mm EMF
1) 140 μW/cm^2
2) 100 μW/cm^2
3) control

The demonstrated increase in amounts of end metabolites of protein metabolism in blood is indicative of possible prevalence of dissimilative processes under the influence of 8-mm wave EMF with EFD of 140 μW/cm^2.

Carbohydrate metabolism is also involved in the body's response to EMF with EFD of 140 μW/cm^2, which is manifested by an average of 13.5% decline of glycogen level in the rat liver (Figure 2). We failed to demonstrate statistically reliable differences from the control in animals exposed to EMF with EFD of 100 and 60 μW/cm^2; however, one can assume that there is a tendency toward decline of glycogen. The changes in glycogen content of animal liver under the influence of microwaves could be attributable to complex metabolic alterations in response to this factor, in particular, impairment of biomembrane permeability, since the glycolytic coenzyme systems are localized in mitochondria.

We observed a decrease in succinate dehydrogenase activity in liver mitochondria with long-term exposure to EFD of 100 and 140 μW/cm^2. Lower EMF, with EFD of 60 μW/cm^2 did not affect activity of succinate dehydrogenase in liver mitochondria. Throughout the experiment, succinate dehydrogenase activity in rat brain mitochondria was in the range of control values (see Table). Exposure to EMF with EFD of 140 μW/cm^2 revealed depression of cytochromoxidase activity in hepatic mitochondria by 15 and 17% after 3 and 4 months, respectively, as compared to the control. Some decline of cytochromoxidase activity was noted under the influence of EFD of 100 μW/cm^2. We observed a persistent decrease in cytochromoxidase activity in mitochondria of the rat brain with EFD of 140 μW/cm^2 starting in the 2d month of exposure and to the end of the exposure period.

In the 3d and 4th months of exposure to EMF with EFD of 140 μW/cm^2, we observed some changes in metalloenzyme activity in rat blood serum. Cerulloplasmin activity increased and there was a decrease in iron content of blood serum transferrin. The observed changes in metalloenzyme activity were apparently due to redistribution of trace elements, iron and copper, under the influence of the electromagnetic field (V. G. Lazarovich).

Blood cholinesterase activity, cytochromoxidase and succinate dehydrogenase in rat liver and brain mitochondria with exposure to different levels of 8-mm wave EMF ($\overline{X}\pm S_{\overline{x}}$)

EFD, μW/cm^2	Exposure time, days	Blood cholinesterase activity, μg/min	Activity, ΔU [units]/mg protein			
			cytochromoxidase		succinate dehydrogenase	
			liver	brain	liver	brain
140	60	109,9±6,9	1,56±0,07	1,34±0,087*	1,40±0,16	1,25±0,10
	90	104,3±8,1*	1,53±0,09	1,37±0,063*	1,32±0,07	1,24±0,10
	120	105,8±9,0**	1,49±0,08*	1,36±0,077*	1,23±0,1*	1,20±0,09
100	60	110,8±8,47	1,53±0,11	1,40±0,102	1,51±0,11	1,32±0,27
	90	112,1±10,0	1,54±0,09	1,49±0,092	1,31±0,15	1,26±0,11
	120	109,12±7,5*	1,43±0,09	1,44±0,097	1,21±0,14*	1,19±0,10
Control	60	129,3±6,88	1,81±0,14	1,63±0,073	1,57±0,14	1,22±0,07
	90	128,9±5,54	1,80±0,09	1,57±0,06	1,48±0,14	1,23±0,10
	120	132,6±5,95	1,80±0,12	1,62±0,067	1,65±0,11	1,30±0,10

* $P<0{,}05$; ** $P<0{,}01$.

The results of our study of blood cholinesterase activity as an indirect indicator of the reaction of the nervous system to 8-mm wave EMF are indicative of a decline of this activity in the 3d and 4th months of exposure with EFD of 140 μW/cm^2, by an average of 20%, as compared to the control (see Table). When rats were exposed to EMF with EFD of 100 μW/cm^2, cholinesterase activity dropped by 17.7% after 4 months. Moreover, it should be noted that with exposure to the tested levels of EMF, there was a tendency toward decrease in activity of this enzyme, though it was not always statistically reliable, at all tested times, starting in the 2d month of exposure.

Analysis of the results shows that intermittent EMF in the 8-mm wave range influences metabolic processes in experimental animals with use of EFD of 140 and 100 μW/cm^2. We observed changes in protein and carbohydrate metabolism, as manifested by an increase in blood serum urea and residual nitrogen content, and decline of glycogen level in the rat liver; there were disturbances in several enzyme systems manifested by increase in ceruloplasmin activity and decreased iron content in blood serum transferrin, depression of blood cholinesterase activity, succinate dehydrogenase and cytochromoxidase activity in mitochondria. These biochemical changes in experimental animals depended on the magnitude of EFD and duration of exposure to 8-mm wave EMF.

The noted metabolic disturbances should, perhaps, be interpreted as the result not only of the suspected resonance absorption of energy by membrane macromolecules (E. Sh. Ismailov and S. M. Zubkova; L. A. Sevast'yanova), but mediated absorption through the neurohumoral regulatory system (N. N. Zalyubovskaya and R. I. Kiselev) of metabolic processes under the influence of electromagnetic fields in the microwave range.

We were also impressed by the fact that the demonstrated changes in tested parameters did not reach pathological levels, which warrants evaluation thereof as compensatory and adaptive reactions of the organism. However, it is rather significant that the above metabolic disturbances occurred in the 3d-4th month of long-term exposure. This warrants the assumption that the effect is cumulative when there is long-term exposure. Consequently, in setting standards for 8-mm wave electromagnetic waves, it is necessary to regulate the factor not only according to level, but time.

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DISTINCTIONS REFERABLE TO ORIENTATION OF ERISTALIS TENAX L. DRONE FLIES IN LASER BEAM

Moscow BIOLOGICHESKIYE NAUKI in Russian No 4, Apr 82 (manuscript received 21 Jan 81) pp 26-29

[Article by L. I. Frantsevich, recommended by the Institute of Zoology, Ukrainian Academy of Sciences]

[Text] Flies and bees present distinct positive phototropism as they move in the beam of a helium-neon laser. Their low sensitivity to red light (633 nm) is compensated by the high power of the beam. At the point of intersection of two beams, drone flies [Eristalis tenax L.] choose the brighter one; standard deviation in distribution of choices constitutes 1.4 log units of relative intensity of beams. Such a large comparison error is related to the nonstationary nature of illumination of the eye with a narrow beam and short time of simultaneous viewing of two beams.

Gas lasers generate monochromatic, coherent, polarized and extremely narrow beams of light. For insects, which use helium-neon lasers as an optical reference point under experimental conditions, the first three properties should not be of appreciable significance. The high power of a guided beam compensates their low sensitivity to red light: both flies and bees present distinct phototropism in a red laser beam. The details of the standing interferential image are not resolved in the long rhabdomere and they are blurred upon movement. Polarization of an extrazenith light source on a dark background does not influence orientation. The main distinction of a laser as a reference point, as compared to a usual point source or projector, is the small divergence of the beam. The section of the beam may be smaller than the section of the insect's eye.

We observed the distinctions of orienting behavior related to narrowness of a beam of light in female Eristalis tenax L. flies.

The phototropic behavior and spectral sensitivity of these flies have been well-studied [1-3, 7, 8, 11]. The complex eyes of this insect contain three types of visual pigments with maximum sensitivity in the range of λ_{max} 350, 450 and 520 nm. Absolute photosensitivity, i.e., flux of light eliciting a response in a dark-adapted eye on the level of 50% of the maximum, constitutes for these receptors (at λ_{max}) $1.4 \cdot 10^{10}$, $3.7 \cdot 10^{10}$ and $4.8 \cdot 10^{9}$ quanta/cm$^2 \cdot$s. Photosensitivity of green-sensitive receptors in red light (633 nm) constitutes 3% of the maximum, according to the nomogram of Dartnall [6]. One can find the analogous characteristic for blue-sensitive receptors by extrapolation of column [graph] 7 in [3]: 0.02%. For a 50% response of receptors, the equivalent effectiveness of a flux of red quanta constitutes $1.6 \cdot 10^{11}$ and $1.9 \cdot 10^{14}$ quanta/cm$^2 \cdot$s. The compound eye of the fly is 3×1.5 mm in size in the frontal section; the frontal ommatidia are 3 mm apart. The diameter of the frontal facets is 26 μm. In a running fly, the center of the eye is 3 mm above the substrate.

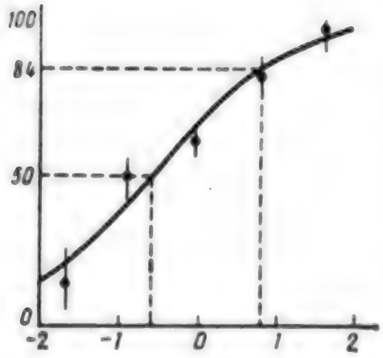
> In our experiments an LG-56 or LG-52 laser (wavelength 633 nm) served as the light source. KS-11 light filters were used to eliminate additional short-wave illumination from the gas discharge within the generator tube. Divergence of the beam constituted 4.4 min. Beam diameter at the working distance was 1.5-2 mm with nominal power of the beam on the order of several milliwatt. Beam intensity was about $1 \cdot 10^{17}$ quanta/cm$^2 \cdot$s/mW, which is greater by several orders of magnitude that the above-mentioned effective levels.
>
> Experiments were conducted in a ring with a black surface in a room with black walls and ceiling. Two laser beams of equalized power were delivered at a height of 3 mm above the surface of the ring. The beams intersected at a right angle in the center of the ring. Optical elements, on the surface of which light was partially scattered, were covered with screens.
>
> We let an insect out in one of the beams (direct beam) and recorded its behavior while moving in the direct beam and at the point of intersection with the lateral [side] beam. We could reduce the brightness of either beam by means of the light filter.

When a fly accelerates while running, the beam passes from the right eye to the left and back with each step. Less often, the insect runs with low acceleration, so that the beam illuminates the fly's antennae all of the time; the eyes are illuminated by the edges of the beam and diffuse halation.

When running at a speed of 2-5 cm/s, the fly intersects the lateral beam in 40-100 ms, and in this time it must make a choice. At the moment of choice, both beams could illuminate the same or different eyes. After making the choice, the fly continues in the former direction, or turns into the lateral beam, or else turns at an intermediate angle, arbitrarily designated as 45°, and goes to the dark area. The Table lists the distribution of choices in 1203 cases referable to 16 flies, demonstrating consistent positive phototropism. The distributions differ considerably from one another according to the χ^2 criterion. The Figure illustrates the reduced distribution of choice of one of the two beams according to relative brightness (after excluding cases of going in an intermediate direction). The position of the curve of normal distribution was determined by the method of probit analysis.

Direction of movement of Eristalis tenax flies at intersection of two beams of light

Fly No	Relative power of beams		Number of observat.	Choice of route, %, in following directions		
	direct	lateral		0°	45°	90°
1—16	0,02	1,00	111	8,0	43	49,0
	0,14	1,00	194	41,5	15	43,5
	1,00	1,00	670	50,4	17	32,6
	1,00	0,14	154	73,0	11	16,0
	1,00	0,02	74	86,0	11	3,0
13	0,02	1,00	30	10,0	90	0
14	0,02	1,00	26	0	0	100,0
4	0,14	1,00	21	0	0	100,0
	1,00	1,00	47	13,0	17	70,0
	1,00	0,14	46	28,0	18	54,0
	1,00	0,02	42	76,0	19	5,0
5	0,14	1,00	47	83,0	15	2,0
	1,00	1,00	40	92,0	8	0
	1,00	0,14	21	100,0	0	0



Choice of one of two intersecting beams. X-axis--logarithm of relative intensity of direct beam; y-axis, frequency of choosing direct beam, %; vertical dashs--95% confidence intervals (987 cases)

In choosing one of the two light sources, the fly compares their brightness. Let us assume that a random interference is added to measurement of exact relative brightness and the final choice is made on the basis of the value of the sum of useful signal and noise. One can estimate the noise parameter as a standard deviation in the integral distribution of choices. When comparing ordinary light sources, the noise parameter constitutes 0.5-1.5 log units of intensity of illumination for bees, ants and flies [4, 5, 9, 10]. In our experiment, the noise parameter can be assessed as the difference between arguments corresponding to 50 and 84% choice (or 16 and 50%). It constitutes 1.4 log, or 25-fold error in comparing source brightness. Several percentage points of light falling on a facet along its optical axis reaches the rhabdomal elements of the apposition eye [12]. The amount of quanta of red light effectively absorbed during the period of choice constitutes at least $1 \cdot 10^3 - 1 \cdot 10^5$. Consequently, quantum noise does not exceed 0.3-3% of the measured source brightness. The cause of great noise in the behavioral reaction is probably spontaneous activity of the insect's brain neurons, and when comparing laser beams the noise increases due to the nonstationary nature of observation in a narrow beam and limited comparison time. The lateral beam is equated in attraction to the direct beam if brightness of the former is 3-4 times greater than of the direct beam.

A tendency toward moving to the brighter source was manifested in all of the flies taken in the experiment. However, it was associated with an individual tendency to turn into the lateral beam or continue running along the direct one. When comparing the direct beam to the bright lateral one, fly No 14 always turned into the lateral beam, whereas fly No 13 more often made only an intermediate turn or continued to run in a straight line. If the tendency to run straight (fly No 5) or, on the contrary, to turn into the lateral beam (fly No 4) was strong, it was necessary to make a major change in intensity of light to overcome it (see Table).

Occasionally, after making a 90° turn and taking a few steps along the lateral beam (with restoration of initial illumination conditions), the insect made a reactive turn in the opposite direction and, having lost the beam, went into the dark area.

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DESTRUCTIVE AND REPARATIVE PROCESSES IN HIPPOCAMPUS WITH LONG-TERM EXPOSURE TO NONIONIZING MICROWAVE RADIATION

Moscow BYULLETEN' EKSPERIMENTAL'NOY BIOLOGII I MEDITSINY in Russian Vol 93, No 3, Mar 82 (manuscript received 4 Nov 81) pp 89-92

[Article by V. S. Belokrinitskiy, Kiev Scientific Research Institute of General and Communal Hygiene imeni A. N. Marzeyev, Ukrainian Ministry of Health, submitted by N. A. Krayevskiy, academician of the USSR Academy of Medical Sciences]

[Text] Key words: nonionizing microwave radiation; hippocampus; destructive and reparative processes.

The data in the literature concerning functional disturbances in the central nervous system of individuals exposed to nonionizing radiation [4-7], as well as the results of our previous studies [1-3], prompted us to conduct special studies to determine the pathogenesis of these disturbances and their clinical manifestations.

We describe here a study of ultrastructural changes in the brain with long-term exposure to nonionizing microwave radiation (NMR) of low intensity. We chose the hippocampus, which is one of the main elements of the limbic systems that is related to many functions of the body, including memory and mental status, as the object of our studies.

Methods

Experiments were conducted on male rats exposed to NMR (wavelength 12.6 cm) for 40 min 3 times a day, at intervals of 3-4 h, at the same time of day for 2 months. One group of animals was exposed to NMR with intensity of 1000 μW/cm^2, another 50 μW/cm^2, the third 25 μW/cm^2 and the fourth 10 μW/cm^2. The animals were irradiated using a Luch-58 unit, with monitoring of dosimetry in an anechoic chamber, in which the rats were placed in special cages. A group of intact rats served as a control. There were 100 animals in each group, and at different times various parameters were determined using physiological, biochemical and histochemical methods.

For electron microscopy, the brain was perfused, adhering thereafter to all stages and rules for examining the ultrastructure of nerve tissue. We submitted three layers of the hippocampus (horn of Ammon) to electron microscopic analysis: alveus, layer of polymorphic cells and layer of pyramidal cells.

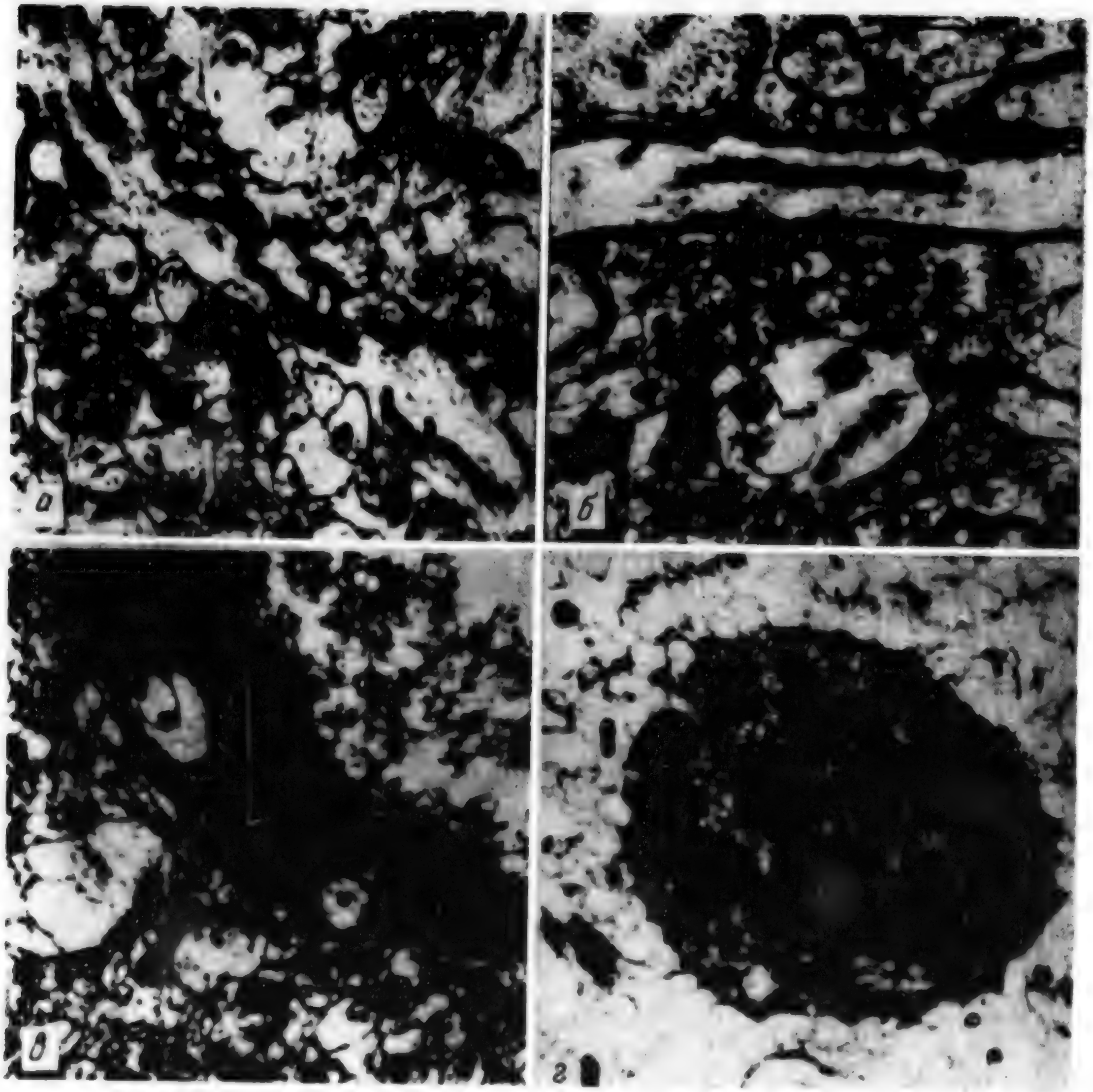

Figure 1. Ultrastructural changes in rat hippocampus with exposure to NMR of 1000 $\mu W/cm^2$ for 2 months

а) alveus layer: swelling of mitochondria in longitudinal section of unmyelinated nerve fiber, increased electron density; magnification 10,800×
б) layer of polymorphic cells: considerable swelling and elongation of mitochondria in longitudinal section of myelinated nerve fiber, local demyelinization and thinning of neurofibrils; magnification 16,000×
в) vacuolization of cytoplasm and structural change in chromatin of polymorphic layer cell; magnification 15,800×
г) condition of microglial cell in polymorphic layer; magnification 14,600×

Results

In animals exposed to NMR with intensity of 1000 μW/cm^2, most of the nerve fibers in the alveus, which consisted mainly of myelinated and unmyelinated nerve fibers that are neural conductors entering and exiting from the hippocampus, had altered structural elements, as compared to the control. Both the sheathes of nerve fibers and neurofibrils of axis cylinders, including their organoids, were altered. The most distinct demonstration of changes was in the mitochondria (Figure 1а). The mitochondria presented considerably enlarged dimensions, altered shapes (convoluted and very long) and electron density: the mitochondria were dark, and the structure of their membranes, cristae and septa was not demonstrable. There was an increased quantity of mitochondria. There was localized demyelinization in the form of clearing of the myelin layer. Ranvier's crosses and Schmidt-Lanterman incisures were not demonstrable. There was irregular thinning of neurofibrils and impairment of their integrity. We encountered vacuolization in virtually all nerve fibers. The vacuoles differed in shape and size. There were many of them. Occasionally droplets were found deep in the fibers, which resembled lipofuscin or altered lysosomes.

We found considerably fewer nerve fibers in the polymorphic cell layer than the alveus. However, here too there was distinct demonstration of fibers with altered structural elements. The nature of the changes was analogous: vacuolization, regressive transformation of myelin, irregular thinning and fragmentation of neurofibrils, swelling and increase in electron density of mitochondria, and others (Figure 1б). In this same layer, there were nerve and glial cells whose structural elements were also considerably altered. More marked changes were found in neurons (Figure 1в). They were characterized by presence of vacuoles differing in shape and size, virtually complete disappearance of organelles from some parts of the cytoplasm with presence of pathological mitochondria in other parts, considerable diffusion and disappearance of chromatin granules in the center of the nucleus and concentration thereof near the membrane (clearing of the nucleus), ectopia of nucleoli. Cytoplasmic and nuclear membranes were not distinct. There was less change in structural elements of neuroglial cells than neurons. They had a more compact nucleus and somewhat cleared cytoplasm (Figure 1г).

The ultrastructure of nerve elements in the pyramidal cell layer also underwent changes. The nature of the changes was analogous to that demonstrated in the preceding layers of this structure. However, they were less marked and frequent than in the alveus and polymorphic cell layer. Here, we encountered more often neurons with virtually normal nucleus, although the cytoplasm of these neurons was vacuolized and there were pathologically altered mitochondria, with absence of other organelles, as indicated by the cleared cytoplasmic sections.

In animals exposed to NMR with intensity of 50 μW/cm^2, vacuolization, localized clearing and disappearance of the myelin sheath, irregular thinning and fragmentation to the extent of complete dissolution of neurofibrils were demonstrable in the alveus, in both myelinated and unmyelinated nerve fibers. Against this background, the pathologically altered mitochondria were more distinct. They were enlarged and presented increased electron density. Their cristae, septa and membranes were not demonstrable. Other organelles were not demonstrable.

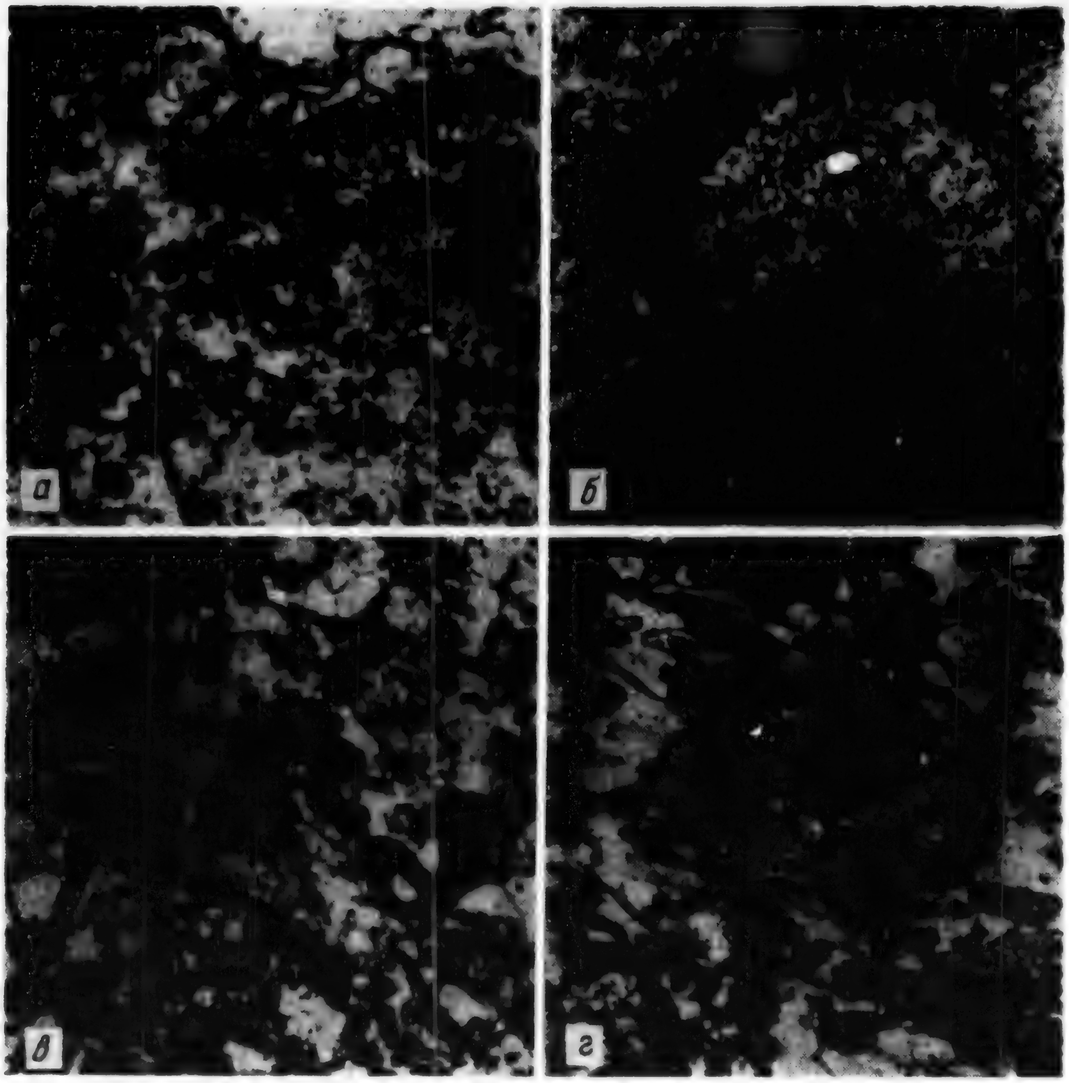

Figure 2. Ultrastructural changes in rat hippocampus with exposure to NMR of 25 $\mu W/cm^2$(*а*, *б*) and 10 $\mu W/cm^2$ (*в*, *г*) for 2 months

а) segment of body of pyramidal layer cell: accumulation of altered mitochondria in one part of the cytoplasm and none in another; magnification 10,000×

б) virtually normal ultrastructure of polymorphous layer cells, magnif. 4600×

в) cross section of nerve fiber (alveus layer) with insignificant mitochondrial changes, magnification 9500×

г) unmyelinated nerve fiber in polymorphic layer, in which two mitochondria with different degrees of destruction of cristae and septa are distinctly visible; magnification 16,000×

In the layer of polymorphic cells, the demonstrated ultrastructural changes in the cytoplasm and nuclei were analogous to those observed in the polymorphic layer of the hippocampus of animals in the preceding series of experiments. However, there was less marked impairment of neuroglial ultrastructure.

In the layer of pyramidal cells, the ultrastructural changes were of the same type as in the analogous hippocampal layer of animals in the preceding series of experiments. However, most of the karyoplasm neurons had a virtually normal appearance, with a normal nucleolus. Such nuclei were seen even in neurons whose cytoplasm was altered.

In animals exposed to NMR with intensity of 25 and 10 $\mu W/cm^2$, we demonstrated less significant changes in ultrastructure than in animals exposed to NMR of higher intensity, and virtually normal cells were encountered (Figure 2). In animals exposed to NMR of 25 $\mu W/cm^2$, preservation of intact neurofibrils was seen more often than in other groups of animals. With emission intensity of 10 $\mu W/cm^2$, along with dark (increased electron density) mitochondria, we saw lighter ones whose structure was partially visualized, and they had an almost normal appearance. There we demonstrated more distinctly the endoplasmic reticulum (although it was altered), which was not observed in the animals used in the preceding series of experiments, as well as neuroglial cells--macrophages and microphages. Their cytoplasm contained many diverse inclusions due to their electron density.

In these groups of animals we occasionally demonstrated structures resembling synapses. However, since many elements inherent in synapses were wanting, we decided not to consider them as synapses.

Thus, it was determined that long-term exposure to NMR with intensity of 1000 to 10 $\mu W/cm^2$ (3 times a day, 40 min at a time, for 2 months) elicits changes in ultrastructure of the hippocampus. The nature of the demonstrated changes is indicative of two opposite processes--destruction and repair--which sometimes take place in the same cell. The intensity of these processes depends on the intensity of NMR. The demonstrated ultrastructural changes can, most probably, affect their function and constitute one of the elements in pathogenesis of early disturbances in people who have been exposed to this environmental factor.

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CLINICAL ASPECTS OF EFFECTS OF VARIABLE MAGNETIC FIELDS ON POSTOPERATIVE COMPLICATIONS

Moscow VESTNIK OFTAL'MOLOGII in Russian No 3, May-Jun 82 (manuscript received 29 Apr 81) pp 56-57

[Article by A. A. Verzin and L. N. Kolesnikova, candidates of medical sciences, Department of Eye Diseases, Therapeutic Faculty of the Second Moscow Medical Institute imeni N. I. Pirogov; Scientific Research Laboratory of "Eye Microsurgery" (headed by A. P. Nesterov, corresponding member of the USSR Academy of Medical Sciences]

[Text] An increasing number of reports has appeared in the last decade concerning the use of variable magnetic fields for treatment of many eye diseases. Magnetic fields are used as an anti-inflammation factor, which anesthesizes and stimulates tissue regeneration.

G. G. Kal'met'yeva (1977), M. V. Zaykova and L. B. Zyuzina (1977) used a stationary magnetic field to treat penetrating wounds to the eyeball. Reduction of the pain syndrome, faster resorption of hyphemas and partial hemophthalmos, regression of signs of traumatic iridocyclitis and faster epithelialization processes were observed.

A variable magnetic field, with intensity of 50-100 Oe, was used in the eye clinic of the Second Moscow Medical Institute imeni N. I. Pirogov for treatment of postoperative complications. This magnetic field was generated by an EMI emitter.* The emitter has a round plastic screen, which is in direct contact with the closed eyelids of the patient during the treatment. The variable magnet is powered by alternating current.

We tested the effects of a variable magnetic field on the following postoperative complications: hyphema, imbibition of blood in the cornea, partial hemophthalmos. For treatment of hyphema, we used a 50-80 Oe variable magnetic field, with exposure for 3 min. We gave 10 treatments and, if necessary, repeated them after 12-14 days. Hemophthalmos and corneal imbibition were treated with variable magnetic field of 80-100 Oe; exposure time was increased to 5-8 min. In the presence of significant hemophthalmos, when there was drastic attenuation of reflex from the fundus and details of the latter could not be visualized by ophthalmoscopy, magnetotherapy was administered twice a day at intervals of 6 h.

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*Verzin, A. A., Usov, M. M. and Svirin, A. V., Rationalization Proposal No 01401, dated 18 June 1980.

Depending on the postoperative complications, the patients were divided into three groups. The first consisted of 18 patients who developed hyphemas occupying one-half to one-third of the anterior chamber on the 1st or 2d day after intracapsular extraction of a cataract. Appearance of a hyphema was usually associated with signs of iridocyclitis. The second group consisted of 11 patients with partial postoperative hemophthalmos; the third group consisted of 4 patients with postoperative imbibition of the cornea with blood due to the long presence of blood in the anterior chamber. The average age of patients submitted to magnetotherapy was 60±7 years; there were 15 men and 18 women. No topical or systemic resorption therapy was prescribed for the first group of patients during the period of magnetotherapy. Systemic resorption therapy was administered to the second and third groups during magnetotherapy.

Dynamics of visual functions before and after treatment with variable magnetic field

Group of patients	Postoperative complications	Number of eyes	Visual acuity		Control group		
			before	after	number of eyes	Visual acuity	
			magnetotherapy			before treatment	after resorption therapy
1	Hyphema	18	0.8±0.09	0.7±0.1	18	0.3±0.06	0.8±0.1
2	Hemophthalmos	11	0.1±0.06	0.5±0.07	11	0.09±0.09	0.4±0.07
3	Corneal imbibition	4	0.02±0.09	0.3±0.09	--	--	--

Concurrently with these three groups, we selected control groups corresponding to them in number, age, sex and condition of eyes. The control groups of patients received local and systemic resorption therapy.

In the first group, resorption of hyphema with use of variable magnetic field occurred after 2-3 treatments in 14 patients (77.2%), after 6-7 treatments in 4 patients (22.8%) whose hyphema occupied half the chamber. In the control group, there was resorption of hyphema within 2-3 days in 9 eyes (50%) and after 8-10 days in 9 others (50%) with use of resorption therapy. In the second* group, there was complete restoration of corneal transparency after 2-3 courses of 10 treatments each. The patients of this group received systemic resorption therapy in the intervals between magnetotherapy. In the third** group, resorption of partial hemophthalmos was noted after 10 magnetotherapy sessions in 6 eyes (54.5%) and after 2 courses of magnetotherapy in 5 eyes (45.5%). In the control group, resorption of partial hemophthalmos after 10 days was noted in only 4 eyes (36.3%) and after 20-30 days in 7 eyes. With the use of magnetotherapy, we observed faster curbing of signs of postoperative iridocyclitis in all patients. We failed to demonstrate adverse side-effects of variable magnetic fields on eye tissues.

Editors note: *this is the third group; **this is the second group

Data on dynamics of visual function before and after variable magnetic field therapy are listed in the Table. It shows that resorption of hyphema, partial hemophthalmus and corneal imbibition with blood occurred much faster with the use of a variable magnetic field. This is a preliminary report. Further clinical and experimental studies are needed of the mechanisms of effects of variable magnetic fields on processes of resorption of hemorrhages. At the present time, there are no reports in the ophthalmological literature concerning the use and mechanisms of effects of variable magnetic fields on resorption of intraocular effusions of blood. In all likelihood, faster resorption of hemorrhages is related to the fact that red blood cells contain hemoglobin, and bivalent iron is one of its constituents. In a variable magnetic field there is oscillation of iron ions, which interacts with negative and positive ion particles, accelerating resorption processes.

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CHANGES IN NERVOUS SYSTEM OF INDIVIDUALS EXPOSED TO MICRORADIOWAVES FOR LONG PERIOD OF TIME

Minsk ZDRAVOOKHRANENIYE BELORUSSII in Russian No 5, May 82 (manuscript received 28 May 81) pp 51-53

[Article by I. N. Gorbach, candidate of medical sciences, Belorussian Scientific Research Institute of Sanitation and Hygiene]

[Text] The problem of effects of electromagnetic fields (EMF) at radio frequencies on the public and individuals serving superhigh-frequency (SHF) generators is constantly growing and becoming more pressing, in view of the extensive use of such generators and increased power of radiation sources.

Although there is an enormous literature dealing with the biological effects of electromagnetic fields (A. S. Presman, 1968; M. I. Yakovleva, 1973, and others), it is difficult to compare the data of different authors, since there are no standard criteria for assessing clinical findings or reliable evidence of a link between reactions of the body and expressly the effect of EMF, nor is there the desired clarity in comprehension of the effects of EMF on man.

It is of great practical importance to investigate working conditions and reactions to chronic exposure to EMF in order to detect early signs (initial manifestations) of pathology and work out optimum medical recommendations.

According to the data in the literature (Yu. A. Kholodov, 1967; G. D. Antimoniy, 1972; V. R. Faytal'berg-Blank et al., 1978, and others), the nervous system turned out to be the most stable and functionally sensitive to EMF.

Material and Methods

We examined 142 people working under conditions of direct exposure to an SHF field, as well as 46 subjects in other specialties, who could not be exposed to SHF electromagnetic radiation. The individuals servicing SHF generators and working in the zone of SHF were periodically exposed to a dosage that was somewhat higher than the MPL [maximum permissible level). These were all men. There were 112 people 20-24 years of age, 20 25-29 years old and 10 30-39 years of age. Their work tenure related to exposure to SHF constituted up to 2 years for 73 men, up to 4 years for 58 and over 5 years for 11. Of the 142 people exposed to SHF on the job, 119 do not recall any prior diseases, 23 reported childhood infections, acute catarrh of the upper respiratory tract and other infectious diseases. A total of 124 men exposed to SHF EMF on the job and 30 in other fields presented various complaints referable to their health status, including neurological complaints (79 and 21 men, respectively). We analyzed only the last two groups of subjects (Table 1).

Table 1. Structure of complaints of subjects chronically exposed to microradiowaves

Complaints	Work tenure			Totals
	to 2 years	to 4 years	over 5 years	
Headache (total)	27	28	9	64
occasional	18	11	1	30
periodic	8	14	4	26
constant	1	3	4	8
in the morning	—	3	4	7
in the evening	27	25	5	57
in occipital region	1	2	—	3
in frontotemporal region	10	14	4	28
without definite localization	16	12	5	33
Vertigo	2	8	5	15
Fatigability	10	12	6	28
Irritability	8	21	8	37
Listlessness, slowness	—	6	5	11
Sleep disorders (total)	15	20	7	42
difficulty falling asleep	8	13	1	22
restless sleep	—	—	1	1
superficial sleep	6	1	—	7
sleepiness	1	6	5	12
Hyperhidrosis (total)	19	23	8	50
generalized	5	11	7	23
distal	14	12	1	27
Memory disorders (total)	14	18	8	40
diminished	8	10	6	24
absent-mindedness	6	8	2	16
Sexual disturbances (total)	6	7	2	15
diminished drive	4	7	2	13
increased	2	—	—	2

Results and Discussion

Table 1 shows that about half the men whose jobs involve exposure to SHF fields presented no complaints about their health; in the others, the complaints were of a general neurotic nature; with increase in tenure there was increase in number and diversity of complaints (cumulative effect of SHF field).

Objective findings of neurological examinations are listed in Table 2.

Table 2. Changes in neurological status of individuals chronically exposed to microradiowaves

Objective findings	Tenure			Totals
	to 2 years	to 4 years	over 5 years	
Anisocoria	11	14	7	32
Adaptive horizontal nystagmus	2	1	1	4
Accentuation of tendon reflexes	14	19	9	42
Decline of abdominal reflexes	2	16	7	25
Muscular hypotonia	—	4	2	6
Hyperhidrosis	12	18	9	39
Palpebral and digital tremor	9	10	7	26
Active facial vasomotors	11	12	8	31
Dermatographism:				
persistent, red	1	3	2	6
transient	8	18	4	30
white	—	1	1	2
Instability in Romberg position	—	4	3	7
Emotional lability	8	13	9	30
Asthenization:				
mild	5	8	4	17
marked	1	2	4	7
Totals	42	27	10	79

Analysis of the data in Table 2 shows that almost all of the individuals exposed chronically to radio-frequency electromagnetic energy and complaining of their health status presented various neurological disturbances (mainly functional). These disturbances can be arbitrarily divided into three main sets of symptoms: vegetovascular dysfunction, vegetovisceral manifestations and asthenic syndrome.

We classified the following as vegetovascular dysfunctions: unstable arterial pressure, "active" facial vasomotors, sensation of febrile face, hyperhidrosis, increasing and profuse red dermographism, vascular paroxysms, etc. If we also demonstrated functional disturbances referable to interval organs and senesthopathy, we classified them as vegetovisceral disorders.

We included in the asthenic syndrome diverse, transient and vague complaints, in the presence of heightened excitability and fatigability of higher nervous activity, tremor of the palpebra and fingers of extended hands, accentuation of tendon and periosteal reflexes, disturbances referable to emotions and conative functions, etc.

In the subjects we examined, there was prevalence of a mixed form of nervous system disturbances (73%), followed by mainly asthenic (17%), vegetovascular (8.5%) and visceral (1.5%) disturbances.

The following were the first manifestations of effects of the SHF field: malaise, increased fatigability, dullness and periodic headache. Subsequently appeared sleep disturbances, deterioration of memory and affect, intensification of headache, irritability and decline of sexual potency.

On the basis of our observations, it can be stated that, with such exposure, the hypothalamic region of the brain is stricken first, where the vital regulatory centers are concentrated; this part of the brain is found to be highly sensitive to physicochemical fluctuations of environmental and other deleterious factors (infection, trauma, poisoning, etc.).

Most subjects exposed to SHF for up to 2 years on their jobs presented no complaints or clinical pathological changes, and some revealed only moderate vegetovascular manifestations.

In those chronically exposed to microwaves for 4 years, we demonstrated the most often asthenic disturbances, followed by vegetovascular and, very seldom, vegetovisceral and endocrine disturbances.

There were marked neurasthenic disturbances in men working with SHF generators for 5 to 15 years, and they presented viscero-endocrine disorders several times more often than the preceding group of subjects.

In the control group, 6.2% presented mainly autonomic and 8.9% general neurotic manifestations, whereas no changes were demonstrable in the rest (83.9%).

Conclusions

1. The biological effects of SHF fields are mediated via the nervous system; evidently, the neurodynamic changes first develop in the hypothalamic region and then in other systems.

2. The effects of SHF fields are aggravated by other deleterious factors and prior diseases.

3. With chronic exposure to SHF energy, sets of symptoms of functional changes in the nervous system were the most typical findings.

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ARGON LASER USED FOR TREATMENT OF PATIENTS WITH SEVERE FORMS OF HERPETIC KERATITIS

Moscow VESTNIK OFTAL'MOLOGII in Russian No 3, May-Jun 82 (manuscript received 20 Jan 81) pp 33-34

[Article by Prof T. I. Yeroshevskiy, V. M. Petukhov, candidate of medical sciences, and V. Yu. Kulagin, graduate student, Department of Eye Diseases (headed by Prof T. I. Yeroshevskiy, corresponding member of the USSR Academy of Medical Sciences), Kuybyshev Medical Institute imeni D. I. Ul'yanov]

[Text] Herpetic keratitis is in one of the first places, according to incidence and severity, among other diseases of the cornea. In recent times, some advances have been made in the treatment of ophthalmoherpes; however, the problem is still far from definitive solution. In this respect, the use of laser radiation energy should be considered promising. There are only isolated reports on this score in the literature (M. M. Krasnov et al., 1975, 1976).

On the basis of the results obtained by the above-mentioned authors in the treatment of patients with epithelial dendriform keratitis, we used the energy of argon laser radiation for severe cases of ophthalmoherpes.

Material and Methods

We treated 30 patients (30 eyes), 10 of whom had dendriform herpetic keratitis, 12 metaherpetic and 8 disciform keratitis, i.e., there was prevalence of serious forms of corneal herpes.

It should be noted that many of the patients had been previously treated for a long time (up to 2-3 months) and unsuccessfuly as both outpatients and in the hospital, with the use of the most modern antiviral agents.

We used the argon laser of the Coherent Radiation firm (United States), model 900, for laser coagulation.

Treatment was administered by the method of M. M. Krasnov et al., and it was combined with topical sulfanilamides, midriatic agents and 0.5% thiamin ointment.

Results

A beneficial response was obtained in all 30 cases, and many of them reported improvement in the condition of the eye already on the day after therapy. There was reduction of signs of photophobia, lacrimation and regression of pain in the eye.

Epithelialization of the cornea occurred on the 2d-5th day in all 10 patients with dendritic herpetic keratotis. In the cases of stromal forms of corneal herpes associated with ulcerations, epithelialization of the cornea occurred on the 6th-10th day in 6 patients and on the 11th-16th day in 14. Resorption of the infiltrate was noted on the 4th-8th day in 10 cases and on the 8th-19th day in 20. There remained an opacity varying in intensity, depending on the severity and depth of prior inflammatory process, at the site of the infiltrate. There was restoration of corneal sensitivity and the eye became relaxed. Visual acuity improved in 12 out of 10 patients with centrally and paracentrally located infiltrates, by the end of the treatment. We failed to demonstrate any changes whatsoever in the iris, lens or fundus in both the short and long term, up to 7 months.

Discussion

The results of treatment are indicative of the desirability of using the energy of argon laser radiation for patients not only with dendriform keratitis, as had been previously demonstrated, but with more severe stromal forms associated with ulcerations. Thanks to the laser, we succeeded in obtaining a cure relatively rapidly, and although the time at which epithelialization of the cornea occurs was longer than observed by M. M. Krasnov et al., this could be attributed to the fact that this was a more serious ill group. It should also be stressed that many patients had been treated for a long time and without success prior to use of the laser.

We agree with M. M. Krasnov et al., that one of the main factors determining the therapeutic effect of laser coagulation is the local elevation of temperature in the treated region and, as a result, inactivation of the virus. Moreover, apparently the stimulating effect of laser energy on trophic processes in the cornea is also of some significance.

Conclusions

1. Argon laser coagulation is an effective method for treating patients with serious forms of herpetic keratitis associated with ulcerations.

2. Use of laser radiation reduces patient treatment time.

3. The advantage of the method is that it is possible to deliver strictly measured doses and solely to the altered part of the cornea.

4. Treatment can be administered not only in a hospital, but on an ambulatory basis.

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LASER SURGERY FOR NEOPLASMS OF THE CONJUNCTIVA AND EYELIDS

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[Article by G. I. Osipov, senior scientist, Department of Eye Diseases (headed by Docent V. V. Lantukh), Novosibirsk Medical Institute]

[Text] A series of experimental and clinical works has been published in recent years concerning the use of carbon dioxide lasers with continuous radiation in oncology (S. D. Pletnev et al., 1978; O. K. Skobelkin et al., 1979; Carruth, 1979, and others). T. Kentsik (1979) obtained positive results from experimental work on the use of carbon dioxide lasers in ophthalmology. All of the authors stress the obvious advantages and potential of laser surgery of tumors.

On the basis of the positive results of experimental and clinical laser surgery, as well as the experience we gained in photocoagulation of neoplasms of the eyelids and conjunctiva (G. I. Osipov et al., 1979), early in 1980 we used the Soviet surgical laser unit, Scalpel-1, for surgical management of benign and malignant neoplasms of the conjunctiva and eyelids. We gained specialization in laser surgery at the Moscow Municipal Clinical Hospital No 51 in the clinic of Prof O. K. Skobelkin. Maximum power of our unit at the guide output constitutes 18 W. The power of radiation was changed in steps to 20, 40, 60 and 80% of the maximum level by means of the light-guide diaphragms. The laser, used in a constant mode, was turned on by means of a pedal. The smallest diameter of the laser spot in the focus of the light-guide lens is 1 mm. The diameter of the spot could be increased to 20 mm by defocusing and changing the power. Products of tissue evaporation and combustion are removed from the operating table with a suction pump outside the operating room. We did not encounter articles on the use of Scalpel-1 in ophthalmology in the literature available to us. Perhaps this is related to the fact that the radiation from a carbon dioxide laser is invisible ($\pi = 10.6$ μm), while the aiming device is not perfect, and allows delivery of the first coagulates only to the nearest ±5-7 mm, and this is not admissible in ophthalmological surgery.

To adapt the Scalpel-1 to the needs of ophthalmic surgery, we developed a sight (Rationalization Proposal No 204, 4 Jan 1981) which enabled us to make incisions and perform coagulation with great precision. In addition to the sight, to limit the surgical field, protect surrounding tissues, eyes of the patient from direct radiation and surgeons from reflected radiation, we used stainless steel diaphragms in the shape of small-radius spheres with holes in the center that differed in diameter (from 2 to 5 mm). In one year, we performed 91 laser operations for various stage T_1 neoplasms (see Table).

Results of surgical management using lasers on neoplasms of the eyelids and conjunctiva

Localization	Clinical diagnosis				Totals
	nevus, papilloma	basiloma epithelioma	melanoma	angioma	
Eyelids	54	20	2	4	80
Conjunctiva	3	--	1	1	5
Limbus	1	--	1	1	3
Lacrimal caruncle	2	1	-	-	
Total treated	60	21	4	6	91

Clinically benign neoplasms, but with a tendency toward rapid growth, were in first place according to number of cases. In second place were locally destructive and malignant tumors. Most patients were treated on an ambulatory basis. Histological confirmation and definition of the clinical diagnosis was obtained in 19 cases, when it was possible to use the laser to cut part of the tumor for testing. We were unable to perform a laser biopsy in many cases because of the small size of the neoplasm.

Anesthesia and treatment of the surgical field were performed by the usual methods of ophthalmological surgery. We used different combinations of three main techniques to remove the neoplasms: 1) resection of tumor with focused beam going 3 mm into healthy tissue; 2) evaporation of neoplasm within the limits of healthy tissue with focused or defocused beams in cases where the small size of the tumors did not permit excision; 3) coagulation with defocused beam without evaporation when there were flat superficial tumors. The dosage of radiation for palpebral surgery, which ranged from 3.6 to 18 W, was determined by the size of the neoplasms. An extremely valuable factor was that, unlike diathermic coagulation, cryoapplications and x-ray therapy, the surgeon can visually assess the amount of tissue removed and can grade his intervention precisely. Histological examination of removed tumors revealed, in the incision region, coagulation necrosis and destructive changes in tissues to a depth of 0.3-0.5 mm. Similar changes occur in healthy tissues after removal of tumors (S. D. Pletnev et al., 1978). Healing was not associated with reactions. At the site of the operation, a sterile crust forms on the palpebral skin. It is recommended that this crust be swabbed 2-3 times a day with brilliant green solution for 5-7 days. Thereafter, an ointment is used on the crust. Epithelialization occurs under the crust, the defect heals and it is sloughed off on the 10th-12th day. A delicate skin is formed at the site of laser intervention, and it very quickly acquires the appearance of the surrounding integument.

Neoplasms of the conjunctiva, eyelids and limbus were evaporated with defocused beam after preliminary anesthesia with 1% dicaine and, in the case of large neoplasms (over 3 mm) after an injection of 2% novocain. Radiation power that we used constituted 3.6-7.2 W. Isolation of the surgical field and protection of the eyes were obtained by means of a spherical diaphragm. Healing occurred with treatment and by the principle of local thermal burn of the conjunctiva. Ultimately, an unnoticeable cicatrix is formed. Two complications were observed after laser intervention: in the first case, after removal of a huge growing nevus of the edge of the eyelid, trichiasis developed--lashes were removed by electroepilation; in the second case, removal of a large melanoma of the limbs was complicated by plastic iridocyclitis, which was treated with midriatic agents with dexazone. There was no recurrence in a 1-year follow-up period.

Conclusions

1. The Scalpel-1 laser surgery unit is a good tool for surgical management of palpebral and conjunctival neoplasms.

2. The results of our work confirm the main beneficial aspects of laser surgery: ablastic nature, bloodless, minimal traumatization of surrounding healthy tissues, possibility of precisely dosing intervention, sterility of surgical field.

3. Healing after laser operations is not associated with reactions and occurs by second intention.

4. The best effect was obtained when using lasers to remove circumscribed neoplasms, both benign and malignant at stage T_1.

We consider it indicated to adopt laser surgery of palpebral and conjunctival neoplasms in ophthalmological practice. When the laser unit is refined (development of light-guide with accurate sight, relay-dispenser of radiation), the indications for carbon dioxide laser use in ophthalmological surgery can be expanded.

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EXPERIMENTAL BASIS FOR USING PULSED LOW-FREQUENCY ELECTRIC CURRENT FOR STIMULATING BONE TISSUE REPARATIVE REGENERATION

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LANDA, V. A., Central Traumatology and Orthopedics Institute
imeni N. N. Priorov, Moscow

[Abstract] Bone tissue regeneration in the radius with a resected diaphysis was studied in rabbits during treatment with low-frequency pulsed current (1 s pulse at 8 s or 3-4 s intervals, 1 hr treatment sessions). The osteogenic effect was greater at an optimum power of 8-10 μA. Maturation and transformation of callus occurred earlier than in control and was related to the more rapid filling of the defect. By day 75 after injury, mineralization of the microstructure of newly formed bone tissue was similar to that of undamaged bone; this occurred after 3 months in control. Radioisotope studies (^{85}Sr) revealed increased radionuclide accumulation near the wound in treated rabbits, which was due to an increase in the amount of bone tissue and not to increased mineralization. Morphological studies showed that the current led to intensified cell proliferation and differentiation with the formation and activation of osteoblasts. Radioisotope and polarographic studies indicated greater blood flow in the damaged area; blood flow dynamics were similar in the experiment and control but the increase in blood flow rate began earlier with treatment. Biochemical tests revealed a higher ATP level in regenerating tissue in treated animals. The electrical treatment stimulated glycolysis (anaerobic and aerobic), which increased the energy available for cell proliferation and differentiation. Electrical stimulation exerted its favorable effect primarily in stage I of bone tissue regeneration and its use should be limited to the first 2-3 weeks. Clinical use of pulsed low-frequency electric current is recommended. References 21: 13 Russian, 8 Western.
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